

What is claimed is:

- 1 1. A method of forming a silicon oxide layer, comprising:
2 positioning a substrate in a deposition chamber;
3 oxidizing a silicon precursor gas in the deposition chamber at a first temperature to
4 form a silicon oxide layer;
5 heating the substrate to a second temperature higher than the first temperature to
6 anneal the silicon oxide layer.

- 1 2. The method of claim 1, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the
3 oxidization of the silicon precursor gas.

- 1 3. The method of claim 2, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the heating
3 of the substrate.

- 1 4. The method of claim 3, wherein the second temperature is approximate to the
2 highest processing temperature subsequently applied to the substrate following formation
3 of the silicon oxide layer.

- 1 5. The method of claim 2, wherein the silicon precursor gas is provided at low
2 pressure.

- 1 6. The method of claim 5, wherein the low pressure ranges from 0.2 to 10 T.

1 7. The method of claim 6, wherein the oxygen-rich environment further comprises at
2 least one gas selected from a group of gases consisting of nitrogen, helium, argon, ozone
3 and steam.

1 8. The method of claim 1, wherein the step of heating the substrate occurs in an
2 environment comprising at least one gas selected from a group of gases consisting of
3 oxygen, nitrogen, helium, argon, ozone and steam.

1 9. The method of claim 1, wherein the second temperature ranges from 700 to
2 1200° C.

1 10. The method of claim 1, wherein the silicon precursor gas comprises at least one
2 gas selected from a group of gases consisting of; tetraethoxysilane (TEOS), silane (SiH_4),
3 dichlorosilane (DCS), diethylsilane (DES), and/or tetramethylcyclotetrasiloxane
4 (TOMCATS).

1 11. The method of claim 1, wherein the silicon oxide layer formed a compressive
2 stress, such that following the step of heating the substrate, the silicon oxide layer has very
3 low internal stress.

1 12. The method of claim 1, further comprising:
2 doping the silicon oxide layer.

1 13. The method of claim 12, wherein the silicon oxide layer is doped with more than
2 one dopants.

1 14. The method of claim 12, wherein doping the silicon oxide layer comprises
2 implanting at least one dopant.

1 15. The method of claim 12, wherein doping the silicon comprises:
2 introducing a dopant containing gas into the deposition chamber.

1 16. A method of forming a microelectromechanical systems (MEMS), comprising:
2 forming a MEMS structure on a substrate; and thereafter,
3 positioning the substrate in a deposition chamber;
4 oxidizing a silicon precursor gas in the deposition chamber at a first temperature to
5 form a silicon oxide layer; and thereafter,
6 heating the substrate to a second temperature higher than the first temperature to
7 anneal the silicon oxide layer.

1 17. The method of claim 16, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the
3 oxidization of the silicon precursor gas.

1 18. The method of claim 17, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the heating
3 of the substrate.

1 19. The method of claim 18, further comprising:

2 etching the silicon oxide layer without producing an etch residue.

1 20. The method of claim 19, wherein etching the silicon oxide layer is performed

2 using one selected from a group consisting of a vapor etch, a wet etch, and a plasma etch.

1 21. The method of claim 20, wherein etching the silicon oxide layer is performed

2 using an HF-vapor etch.

1 22. The method of claim 16, wherein the second temperature is approximate to the

2 highest processing temperature applied to the substrate following formation of the silicon

3 oxide layer.

1 23. The method of claim 16, wherein the silicon precursor gas is provided at low

2 pressure.

1 24. The method of claim 17, wherein the oxygen-rich environment further comprises

2 at least one gas selected from a group of gases consisting of nitrogen, helium, argon,

3 ozone and steam.

1 25. The method of claim 19, wherein heating the substrate occurs in an

2 environment comprising at least one gas selected from a group of gases consisting of

3 oxygen, nitrogen, helium, argon, ozone and steam.

1 26. The method of claim 16, wherein the second temperature ranges from 700 to
2 1200° C.

1 27. The method of claim 21, wherein etching the silicon oxide layer further
2 comprises:

3 applying a first etching process to the silicon oxide layer which forms an etch
4 residue;

5 oxidizing the etch residue; and

6 applying a second etching process to the oxidized etch residue.

1 28. The method of claim 27, wherein at least one of the first and second etching
2 processes comprises a HF-vapor etch.

1 29. The method of claim 16, wherein the silicon precursor gas comprises at least
2 one gas selected from a group of gases consisting of; tetraethoxysilane (TEOS), silane
3 (SiH_4), dichlorosilane (DCS), diethylsilane (DES), and/or tetramethylcyclotetrasiloxane
4 (TOMCATS).

1 30. The method of claim 16, wherein the silicon oxide layer is formed with a
2 compressive stress, such that following the step of heating the substrate, the silicon oxide
3 layer has very low internal stress.

1 31. A method of sealing a chamber of an electromechanical device having a
2 mechanical structure overlying a substrate, wherein the mechanical structure is in the
3 chamber, the method comprising:
4 depositing a sacrificial oxide layer over at least a portion of the mechanical structure
5 by oxidizing a silicon precursor gas at a first temperature;
6 annealing the sacrificial oxide layer at a second temperature higher than the first
7 temperature;
8 depositing a first encapsulation layer over the sacrificial oxide layer;
9 forming at least one vent through the first encapsulation layer to allow removal of at
10 least a portion of the sacrificial oxide layer;
11 removing at least a portion of the sacrificial oxide layer to form the chamber;
12 depositing a second encapsulation layer over or in the vent to seal the chamber
13 wherein the second encapsulation layer is a semiconductor material.

1 32. The method of claim 31, wherein depositing the sacrificial oxide layer is
2 performed in an oxygen-rich environment.

1 33. The method of claim 32. wherein annealing the sacrificial oxide layer is
2 performed in an oxygen-rich environment.

1 34. The method of claim 31, wherein the semiconductor material is comprised of
2 polycrystalline silicon, amorphous silicon, silicon carbide, silicon/germanium, germanium, or
3 gallium arsenide.

1 35. The method of claim 34, wherein the first encapsulation layer is comprised of a
2 polycrystalline silicon, amorphous silicon, germanium, silicon/germanium or gallium
3 arsenide.

1 36. The method of claim 31, wherein a first portion of the first encapsulation layer is
2 comprised of a monocrystalline silicon and a second portion is comprised of a
3 polycrystalline silicon.

1 37. The method of claim 31, wherein removing at least a portion of the sacrificial
2 oxide layer to form the chamber comprises:
3 exposing the sacrificial oxide layer to an etching process through the vent.

1 38. The method of claim 37, wherein the etching processes comprises a HF-vapor
2 etching process.

1 39. The method of claim 31, wherein the silicon precursor gas comprises at least
2 one gas selected from a group of gases consisting of; tetraethoxysilane (TEOS), silane
3 (SiH_4), dichlorosilane (DCS), diethylsilane (DES), and/or tetramethylcyclotetrasiloxane
4 (TOMCATS).

40. The method of claim 31, wherein the silicon oxide layer is formed with a compressive stress, such that following the step of heating the substrate, the silicon oxide layer has very low internal stress.

1 41. A method of forming a silicon oxide layer, comprising:
2 positioning a substrate in a deposition chamber;
3 decomposing a silicon precursor gas in the deposition chamber at a first temperature
4 to form a silicon oxide layer;
5 heating the substrate to a second temperature higher than the first temperature to
6 anneal the silicon oxide layer.

1 42. The method of claim 41, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the
3 decomposition of the silicon precursor gas.

1 43. The method of claim 42, further comprising:
2 providing an oxygen-rich environment in the deposition chamber during the heating
3 of the substrate.

1 44. The method of claim 43, wherein the second temperature is approximate to the
2 highest processing temperature subsequently applied to the substrate following formation
3 of the silicon oxide layer.

1 45. The method of claim 42, wherein the silicon precursor gas is provided at low
2 pressure.

1 46. The method of claim 45, wherein the low pressure ranges from 0.2 to 10 T.

1 47. The method of claim 46, wherein the oxygen-rich environment further comprises
2 at least one gas selected from a group of gases consisting of nitrogen, helium, argon,
3 ozone and steam.

1 48. The method of claim 41, wherein the step of heating the substrate occurs in an
2 environment comprising at least one gas selected from a group of gases consisting of
3 oxygen, nitrogen, helium, argon, ozone and steam.

1 49. The method of claim 41, wherein the second temperature ranges from 700 to
2 1200° C.

1 50. The method of claim 41, wherein the silicon precursor gas comprises at least
2 one gas selected from a group of gases consisting of; tetraethoxysilane (TEOS), silane
3 (SiH_4), dichlorosilane (DCS), diethylsilane (DES), and/or tetramethylcyclotetrasiloxane
4 (TOMCATS).

1 51. The method of claim 41, wherein the silicon oxide layer formed a compressive
2 stress, such that following the step of heating the substrate, the silicon oxide layer has very
3 low internal stress.

1 52. The method of claim 41, further comprising:
2 doping the silicon oxide layer.

1 53. The method of claim 52, wherein the silicon oxide layer is doped with more than
2 one dopants.

1 54. The method of claim 52, wherein doping the silicon oxide layer comprises
2 implanting at least one dopant.

1 55. The method of claim 52, wherein doping the silicon comprises:
2 introducing a dopant containing gas into the deposition chamber.